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2011 Western Upper Peninsula Moose Survey

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ABSTRACT

We conducted an aerial survey in January 2011 to estimate moose abundance in the Western Upper Peninsula of Michigan. We observed 219 moose during the survey and estimated a population of 433 animals with a sightability correction model. The 95% confidence limits of the 2011 estimate overlap those from the 2006, 2007, and 2009 surveys indicating no statistical difference among these estimates. Fitting an exponential growth model to survey data from 1997-2011 suggests the population grew, on average, about 9% per year. Recommendations for future surveys include the continued strategy of surveying all high-density plots, periodic assessment of plot stratum assignments, and mandatory training of observers.

INTRODUCTION

Moose (*Alces alces*) are native to Michigan and occurred throughout all but the southwestern part of the Lower Peninsula prior to European settlement (Verme 1984, Baker 1983). The Lower Peninsula is at the southern edge of moose range in North America and moose probably were never abundant in this region of the state (Dodge 2002). The influx of settlers resulted in increased hunting pressure and habitat changes, which caused moose numbers to decline. By the early 1880s, moose were extirpated from the Lower Peninsula and numbers were declining in the Upper Peninsula (Wood and Dice 1923). Moose were given full legal protection in 1889 but the protection did not lead to long-term recovery. It is unknown if moose were ever completely eliminated from the Upper Peninsula. It is possible that a small remnant population persisted in

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the Upper Peninsula, although moose could have died out and then reestablished through immigration from Ontario (Dodge 2002). The State made an attempt to reintroduce moose to the Upper Peninsula in the mid 1930s when sixty-three moose from Isle Royale were released in various parts of the Upper Peninsula. Initially, moose numbers appeared to be growing based on the number and distribution of sighting records, however by the mid 1940s the population had again declined and the reintroduction attempt was judged a failure. In 1985, the Michigan Department of Natural Resources released 29 moose originating from Algonquin Provincial Park, Ontario, Canada into the north central Upper Peninsula in an attempt to reestablish a herd. Two years later, 30 additional animals from Algonquin were released in the same general area. The goal of these reintroductions was to a produce a self-sustaining population of free ranging moose. It was hoped that the population would reach 1000 animals by 2000; however, that objective was not reached.

Monitoring moose abundance is important for assessment of the population's status. In addition, any consideration for a hunting season for this species requires reliable abundance estimates collected over multiple years. Moose are on the list of Michigan game species and Public Act 366 of 2010 authorized the Natural Resources Commission (NRC) to establish of the first moose hunting season since the late 1800s if it so chooses. Public Act 366 also created the Moose Hunting Advisory Council (MHAC) to make recommendations to the NRC on expanding moose hunting, evaluate the economics of moose hunting, and propose season dates and quotas. Population trend data are critical to MHAC's deliberations and their recommendations are due December 22, 2011.

The current strategy is to estimate moose abundance every other year using a fixed-wing aircraft survey in conjunction with a sightability model to correct the counts for animals that survey observers miss. This report summarizes the results of a moose population survey conducted in January 2011 in the Western Upper Peninsula.

SURVEY AREA

The moose reintroduced in 1985 and 1987 were released in western Marquette County (Fig. 1). Since their release, moose have increased in number and range and now are found in parts of Marquette, Baraga, and Iron counties. Our knowledge of the distribution or range of moose in the Western Upper Peninsula is based on the movements of radio-collared animals, as well as air and ground reconnaissance and aerial survey work. The moose range is approximately 3,550 km^2 (~ 1,370 mi^2).

The Western Upper Peninsula moose range is divided by two physiographic regions. The north and northeastern portion of the range falls within the Michigamme Highlands (Subsection IX.2) and the south and southwestern portion occurs within the Upper Wisconsin/ Michigan Moraines (Subsection IX.3; Albert 1995). The Michigamme Highlands subsection is characterized by granite bedrock at or near the ground surface with many lakes and swamps in the glacially formed depressions in the bedrock. End and ground moraines and several types of wetlands characterize the Upper Wisconsin / Michigan Moraines subsection.

Northern hardwoods forests are found in upland areas throughout the moose range. White pine (*Pinus strobus*), red pine (*Pinus resinosa*), and trembling aspen (*Populus tremuloides*) are found on rocky ridges. Balsam fir (*Abies balsamea*), black ash (*Fraxinus nigra*), eastern hemlock (*Tsuga canadensis*), northern white cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), trembling aspen, white spruce (*Picea glauca*), and yellow birch (*Betula alleghaniensis*) are found on moderately to poorly drained sites and may occur in pure or mixed stands. Wetlands such as bogs, hardwood or conifer swamps and speckled alder (*Alnus incana*) occur in areas where the bedrock is near the surface. Willow (*Salix spp*.), an important moose food, only occurs in scattered patches.

The climate of the area is continental with seasonally variable temperatures. Winter temperatures in the moose range are often 9-12 ºC colder than temperatures near Lake Superior. From 1951-1980, the mean daily low temperature in January measured at Champion, which is located on the east side of the moose range, was -17.5 ºC. The mean daily maximum temperature was -6.0 ºC. Also, for the same time period and location, the mean daily minimum and maximum temperatures in July were 10.0 ºC and 25.8 ºC, respectively. Mean annual snowfall was 350 cm and mean annual rainfall was 85 cm (Berndt 1988).

METHODS

The density of moose varies across the range moose range, with the core range (~ 1,743 km^2; 673 mi^2) having about 19 moose per 100 km^2 in 2007. Surrounding this core area is an area (1,805 km^2; 697 mi^2) of relatively low moose density (~ 1 moose/100 km^2 in 2007). Using past survey results and field reconnaissance, we allocated portions of the moose range into high and low moose density strata.

We divided the high and low-density strata into 31 high-density and 26 low-density survey plots. For the 2011 survey, we added 3 plots to the high-density stratum based on previous survey results and pre-survey flights that indicated increased moose abundance in these areas. The survey plots were rectangular and typically 3.2 km wide and 19.3 km long (2 miles wide and 12 miles long), although a few plots were larger or smaller. Seventy-nine percent of survey plots were oriented North-South. Survey transects were established for each plot using Global Positioning System (GPS) coordinates. Transects were spaced every 0.4 km (.25 miles) which allows the entire survey plot to be searched. Surveys were conducted by a pilot and 2 observers using Cessna 182 aircraft with their wheel covers removed. The pilot did not attempt to spot moose. Observers collected data from the back seat of the plane to mimic the setup used during development of the sightability model. Transects were flown at speeds of 80 to 90 knots and an altitude of about 152 m (500 ft).

We conducted all surveys flights in January 2011. Surveys were not conducted when wind speed exceeded 24 km/hr or during periods of heavy snowfall. We conducted all flights between 0900–1600 hours to take advantage of good light conditions and minimize shadow effects. We only conducted flights when conditions were deemed safe by the pilots.

Weather conditions, including percent cloud cover, presence/absence of precipitation, temperature, wind speed, and wind direction as well as snow age and snow cover on the ground and on conifers were recorded when each plot was surveyed. Light conditions, including type (bright or flat) and intensity (high, medium, and low) were recorded for each plot. Because light conditions often change throughout a survey, the conditions observed throughout the majority of the survey were recorded. For each moose or group of moose observed, we determined the activity (bedded, standing, or running; activity of the most active moose was recorded) of the animals, the percent vegetative cover to the nearest 5% in a 10 m radius surrounding the first moose spotted, and number of moose in the group. We also attempted to classify the sex and age class (adult or calf) of each moose observed. Bulls with antlers were assigned to one of three antler classes; cervicorn (class 1), palmated-small (class 2), or palmated-large (class 3; Oswald 1982). A GPS location was recorded for each moose group observed. These locations were checked after each flight to ensure that each moose group observed was located within the surveyed plot. Each observer collected independent estimates of vegetative cover and light conditions.

Because moose density is relatively low, a high proportion of the range must be surveyed to reduce variance surrounding the population estimate. We planned to survey all 31 of the high-density plots and 15 of the 26 low-density plots. Surveys were started in the plots near the center of the high density stratum. We then surveyed plots moving towards both sides of the high density stratum. Low density plots were surveyed after the high density plots were completed.

Abundance estimates for each stratum were determined by correcting the aerial counts with a sightability model (Steinhorst and Samuel 1989). Stratum estimates were then summed to estimate total population size. A sightability model is a logistic regression model used to adjust counts of moose from aerial surveys for the probability of detection. The sightability model contains covariates believed to influence the probability of observers sighting a moose group. The sightability model was developed specifically for the Western Upper Peninsula moose population (T. D. Drummer, unpublished data) and takes the following form:

$$\text{logit(Detection)} = 0.64 - 1.26*\text{Vegetative Cover} + 0.5*\text{Group Size}$$

The sightability model has two covariates: group size and vegetative cover. The estimates of vegetative cover for each moose group made independently by each observer are averaged and classified into one of three levels (< 33%, 34-66%, and > 66%).

RESULTS and DISCUSSION

We conducted the 2011 Western Upper Peninsula moose survey from January 9 through January 30. We surveyed all 31 plots in the high-density stratum and a random selection of 15 of 26 plots in the low-density stratum. We completed the survey in 11 days of flying, similar to previous surveys (Table 1). Survey conditions were good, but we lost 4 days at the beginning of the survey period because of inadequate snow cover. Weather conditions forced us to cancel flights on 12 days. The number of observers increased again this year, and we used staff from other Divisions as spotters on a number of flights. A detailed accounting of survey effort is shown in Table 1.

We observed 219 moose on the survey plots, up from the 175 animals observed in 2009 (Table 1, Fig. 2), although we did survey 8 more plots in 2011. Using the sightability model, we estimate a population of 433 animals with a mean percent error of $\pm$ 26%. The 95% confidence limits of the 2011 estimate overlap those from the 2006, 2007, and 2009 surveys indicating no statistical difference among these estimates. The estimate for the high-density stratum continues to have reasonable precision (i.e., $\pm$ 17%; Table 1). Increasing the number of low-density plots surveyed did reduce the variance estimate for this stratum, but the precision of this stratum's estimate remains low. Fitting an exponential growth model to the estimates from 1997-2011 suggests the population is growing at an annual rate of about 9% ($P = 0.0002$; Fig. 3). However, it is important to recall the current estimate changed little from the 2009 estimate of 420 animals. The southwestern (Tracy Creek area) and northeastern (Silver Lake Basin area) parts of the high-density stratum continue to support the greatest numbers of moose.

Based on the moose observed, we estimate there were 56 calves per 100 cows with a twinning rate of 23%, similar to 2009. The percent calves in the population, perhaps a less biased metric than the calf: cow ratio, was also similar to the previous surveys (Table 1) and has averaged 21% over the last 4 surveys.

The sightability correction model consists of two components: group size and canopy cover. In 2011, the average group size was 2.2, similar to the average group size observed in 2009 (2.3) and falling between the average group sizes observed in 2006 (1.9) and 2007 (3.7). The distribution of moose observations assigned to the three canopy cover classes was similar to the 2006 and 2007 surveys (Fig. 4).

RECOMMENDATIONS

1. Biologists should conduct pre-survey flights to assess the need to revise the plot stratum assignments.
2. Continue to survey all high density plots even if plots are added to this stratum.
3. Continue surveying additional low density plots to improve precision of the estimate.
4. Require all observers to attend the pre-survey training session.

5. Observers should take pre-survey flights to become familiar with the proper sight picture for moose and canopy cover. These pre-survey flights should pair experienced observers with less experienced observers to ensure standardization of canopy cover measurements.

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Table 1. Survey effort and results of the 2006, 2007, 2009, and 2011 Western Upper Peninsula moose surveys.

Variable	2006	2007	2009	2011
<u>Survey Effort</u>				
Number of days scheduled	28	28	25	27
Number of days flown	11	11	9	11
Number of flights scheduled	59	63	47	60
Number of flights completed	21	22	18	22
Number of high density plots completed	28	28	28	31
Number of low density plots completed	10	10	10	15
Total plots completed	38	38	38	46
Plots completed on weekends	19	7	9	14
Plots/flight	1.8	1.7	2.1	2.1
Number of pilots	4	3	3	3
Number of observers	7	9	12	16
Days cancelled due to weather	17	6	13	12
Days cancelled due to survey conditions	0	11	0	4
<u>Survey Results</u>				
Bulls				
Number of class 1 bulls			13	29
Number of class 2 bulls			19	29
Number of class 3 bulls			16	19
Number of unknown class bulls			13	17
Number of cows			64	77
Number of calves			41	43
Number of cows of unknown age			4	0
Number of moose of unknown sex and age			5	5
Total number of moose observed	133	155	175	219
Population estimate	347	356	420	433
95% confidence limits	238-456	258-454	259-581	322-544
Percent error	31	28	38	26
Calves/100 cows			64	56
Twinning rate (%)			16	23
Percent calves	21	20	23	20
Bulls/100 cows			95	122
<u>Survey Results by Stratum</u>				
High density population estimate	305	332	339	378
High density 95% confidence limits	227-383	249-415	269-409	316-442
High density percent error	26	25	21	17
High density percent of total population	88	93	81	87
Low density population estimate	42	24	81	55
Low density 95% confidence limits	0-103	0-63	0-172	8-102
Low density percent error	145	163	112	85
Low density percent of total population	12	7	19	13

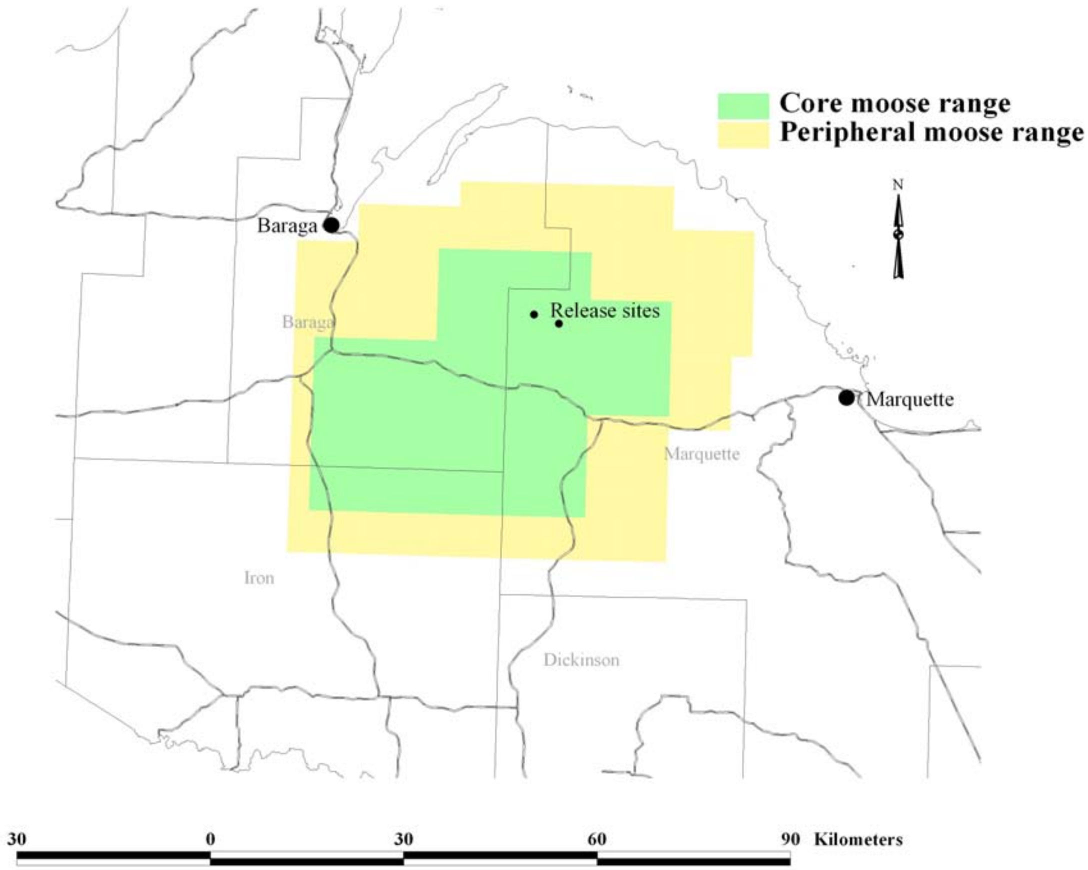

Figure 1. Core and peripheral moose range in the Western Upper Peninsula of Michigan.

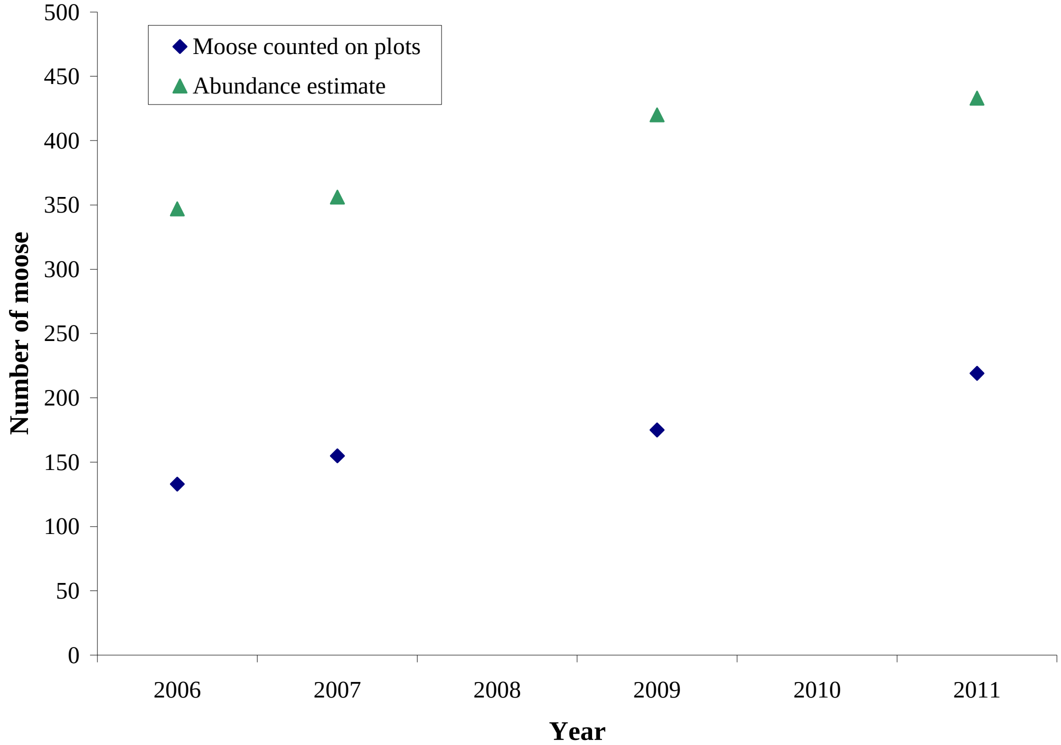

Figure 2. Number of moose counted on survey plots and abundance estimates based on aerial survey counts corrected for visibility bias with a sightability model for the Western Upper Peninsula of Michigan during 2006, 2007, 2009, and 2011. The number of plots surveyed was the same in 2006-2009 (n=28 high density and 10 low density). In 2011, 3 plots were added to the high-density stratum (n=31; all surveyed) and 15 of 26 low-density plots were surveyed.

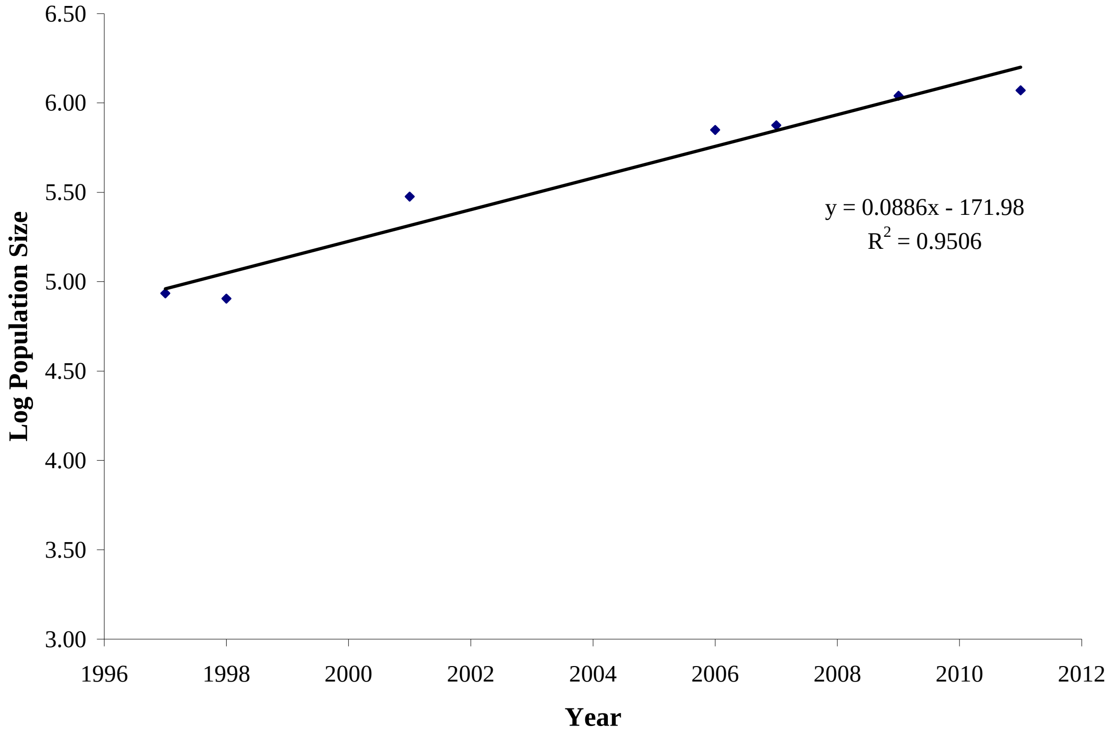

Figure 3. Exponential growth model (logarithmic form) fitted to moose abundance estimates (aerial counts corrected for visibility bias) from the Western Upper Peninsula of Michigan, 1997-2011.

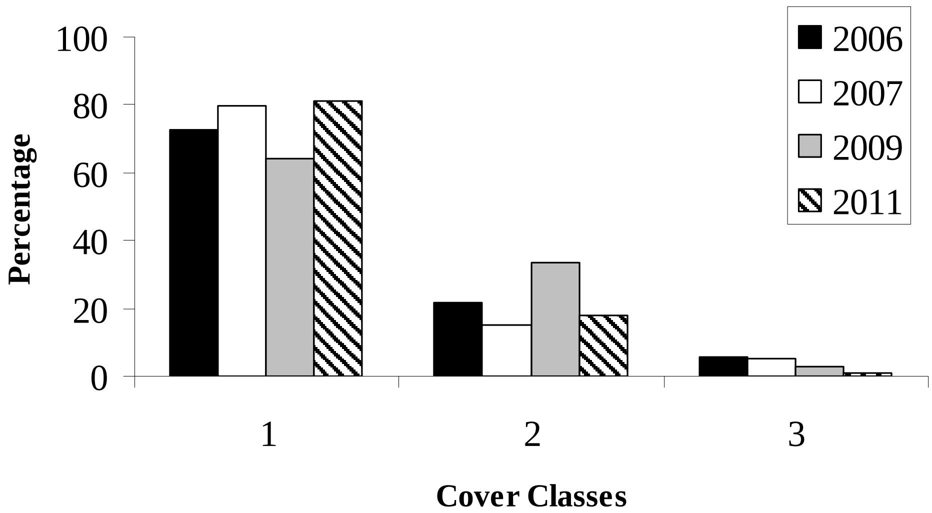

Figure 4. Percentage of moose observations in three canopy cover classes (class 1 = 0-33%; class 2 = 34-66%; and class 3= 67-100%) during surveys conducted in the Western Upper Peninsula of Michigan in 2006, 2007, 2009, and 2011.